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Malaria Prevalence among Resident and Conflict-Displaced Populations in Dongola, Sudan: A Rapid Diagnostic-Based Cross-Sectional Study

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Abstract

Background: Malaria remains a major public health challenge in Sudan, particularly in areas affected by population displacement. This study aimed to determine the prevalence of Plasmodium falciparum malaria among resident and conflict-displaced populations in Dongola City, Northern Sudan.

Methods: A community-based cross-sectional study was conducted between January and June 2025. A total of 100 participants were enrolled, including 50 residents and 50 displaced individuals. Blood samples were collected and screened for P. falciparum using an immunochromatographic rapid diagnostic test (ICT). Demographic characteristics and potential risk factors, including mosquito net use, sleeping location, and proximity to water sources, were collected using structured questionnaires. Data were analyzed using SPSS, and associations were assessed using Chi-square tests with a significance level of $p < 0.05$.

Results: The overall malaria prevalence was 38%. Prevalence was 34% among residents and 42% among displaced individuals, with no statistically significant difference between the two groups ($p = 0.67$). Mosquito net use was significantly associated with malaria infection among displaced individuals ($p = 0.001$) but not among residents ($p = 0.34$). Sleeping location and proximity to water sources showed no significant association with malaria infection in either group.

Conclusion: Malaria remains prevalent in Dongola, affecting both resident and displaced populations. Strengthening vector control measures and promoting proper mosquito net utilization are essential to reduce malaria transmission in this setting.

Keywords

Malaria, Plasmodium falciparum, rapid diagnostic test, displaced populations, Sudan.

Introduction

Malaria remains a significant public health burden in Sudan, with the country accounting for a substantial proportion of malaria cases in the Eastern Mediterranean Region [1]. Northern Sudan, including Dongola city, exhibits unique eco-epidemiological characteristics that influence malaria transmission patterns, characterized by arid environmental conditions and distinct seasonal variations [2]. Population displacement due to conflict further exacerbates the risk of malaria transmission due to limited access to healthcare, poor living conditions, and inadequate vector control measures [3].

The recent influx of conflict-displaced populations into this region

has introduced new challenges, potentially straining local health infrastructure and altering disease dynamics [4,1]. Understanding the disease burden in both resident and displaced communities is crucial for effective public health planning and targeted intervention strategies in this humanitarian context [2,5].

Rapid diagnostic tests (RDTs), such as immunochromatographic tests (ICT), have become essential tools for malaria diagnosis in resource-limited settings. They provide quick results and require minimal training, making them ideal for field use [6]. However, variable performance due to factors such as parasite density, antigen persistence, or gene deletions may affect their accuracy [7]. This study aimed to assess the prevalence of Plasmodium falciparum malaria and identify associated risk factors among both resident and displaced populations in Dongola, northern Sudan.

Methods

Study Design and Area:

A cross-sectional study was conducted in Dongola City, Northern State, Sudan, from January to June 2025.

Study Population and Sampling:

A total of 100 participants (50 residents and 50 displaced individuals) aged 18–60 years were included. Pregnant women, severely ill patients, and those who had taken antimalarials within the previous two weeks were excluded.

Data and Sample Collection:

Venous blood samples were collected aseptically. A structured questionnaire was used to record demographic data, mosquito net use, sleeping habits, and water source proximity.

Malaria Testing:

Samples were tested using a commercial P. falciparum-specific ICT kit (SD BIOLINE Malaria Ag Pf) according to the manufacturer's instructions.

Statistical Analysis:

Data were analyzed using SPSS. Chi-square tests were applied to assess associations, with a p-value < 0.05 considered statistically significant.

Ethical Considerations:

Ethical approval was obtained from the Institutional Review Board of the International University of Africa. Verbal informed consent was obtained from all participants prior to sample collection.

Results

Overall Malaria Prevalence:

A total of 100 participants were included in this study, comprising 50 residents and 50 conflict-displaced individuals. The overall prevalence of malaria infection detected by immunochromatographic test (ICT) was 38% (38/100), with 62% (62/100) testing negative for Plasmodium falciparum antigen.

Malaria Prevalence by Population Groups:

A cross-sectional analysis of 100 participants revealed an overall malaria prevalence of 38% (38/100) by immunochromatographic testing. As detailed in Table 1, the prevalence among resident participants was 34% (17/50), while a slightly higher prevalence of 42% (21/50) was observed among displaced individuals. However, this difference in prevalence between the two groups was not statistically significant (p = 0.67), suggesting a comparable burden of malaria infection in both populations within the study area.

Table 1: Prevalence of Plasmodium falciparum malaria among resident and conflict-displaced populations in Dongola City, Northern Sudan, January–June 2025 (n = 100).

Risk Factor	Category	Positive (n)	Negative (n)	P-value
Sleeping Location	Indoors	12	27	0.82
	Outdoors	05	06	
Mosquito Net Use	Users	06	09	0.34
	Non-users	11	24	
Water Source Presence	Present	08	20	0.83
	Absent	06	13	

Analysis of Risk Factors among Resident Participants:

The relationship between potential risk factors and malaria infection was investigated separately for each group. For the resident population, several factors were evaluated, as summarized in Table 2. The use of mosquito nets was reported by only 15 residents (30%). Among these users, 6 (40%) were positive for malaria, compared to 11 (31.4%) positives among the 35 non-users; this association was not statistically significant (p = 0.34). Furthermore, no significant associations were found between malaria infection and either sleeping location (indoors vs. outdoors, p = 0.82) or the reported presence of nearby water sources (p = 0.83).

Table 2: Association between selected risk factors and Plasmodium falciparum malaria infection among resident participants in Dongola City, Northern Sudan (n = 50).

Risk Factor	Category	Positive (n)	Negative (n)	P-value
Sleeping Location	Indoors	12	27	0.82
	Outdoors	05	06	
Mosquito Net Use	Users	06	09	0.34
	Non-users	11	24	
Water Source Presence	Present	08	20	0.83
	Absent	06	13	

Analysis of Risk Factors among Displaced Participants:

A distinct pattern of risk factors emerged among the displaced individuals, as detailed in Table 3. A notably high proportion of this group (76%, 38/50) reported using mosquito nets. Statistical analysis revealed a significant association between net usage and malaria infection (p = 0.00). Interestingly, a higher number of net users tested positive (12 individuals) compared to non-users (9 individuals). Conversely, similar to the resident group, no significant associations were found for sleeping location (p = 0.47) or the presence of water sources (p = 0.93) with malaria status in the displaced population.

Table 3: Association between selected risk factors and Plasmodium falciparum malaria infection among conflict-displaced participants in Dongola City, Northern Sudan (n = 50).

Risk Factor	Category	Positive (n)	Negative (n)	P-value
Sleeping Location	Indoors	18	20	0.47
	Outdoors	03	09	
Mosquito Net Use	Users	12	26	0.001
	Non-users	09	03	
Water Source Presence	Present	07	10	0.93
	Absent	14	19	

Discussion

This study reveals a high prevalence of Plasmodium falciparum malaria (38%) in Dongola, Northern Sudan, indicating sustained

transmission intensity in this arid region. The comparable infection rates between resident (34%) and displaced (42%) populations, without statistical significance (p=0.67), presents an important finding that contrasts with typical patterns in conflict-affected settings where displaced populations usually experience substantially higher malaria burden [8]. This similarity may reflect shared environmental exposures, comparable healthcare access, or the extended duration of displacement leading to convergent risk profiles.

The differential impact of mosquito net usage between the two study groups provides crucial insights for intervention planning. Among residents, the lack of significant protective effect (p=0.34) despite 30% net usage rate suggests potential limitations in net quality, improper usage patterns, or emerging insecticide resistance in local mosquito populations [9]. This observation aligns with growing evidence of reduced intervention effectiveness in certain settings, necessitating updated resistance monitoring and alternative vector control approaches.

Conversely, the significant association between net usage and malaria infection among displaced individuals (p=0.00) presents a complex scenario requiring careful interpretation. While 76% of displaced individuals reported net usage, the substantial number of infections among users suggests nets may have been distributed reactively to higher-risk groups already experiencing elevated exposure. This pattern underscores the importance of proactive, universal coverage rather than targeted distribution in humanitarian responses [3].

The absence of significant associations with traditional environmental risk factors, including sleeping location and water source proximity, in both population groups indicates multifaceted transmission dynamics that extend beyond conventional risk parameters. This may reflect widespread vector breeding sites throughout the study area or the predominance of indoor biting by local Anopheles species, diminishing the protective effect of sleeping indoors. Recent entomological investigations in Northern Sudan have documented the adaptability of malaria vectors to diverse breeding habitats, including artificial containers and irrigation systems prevalent in both residential and displacement settings [10].

While this study provides valuable insights into malaria epidemiology in a humanitarian context, several limitations should be acknowledged. The cross-sectional design precludes establishing causal relationships between risk factors and malaria infection. The relatively modest sample size may have limited statistical power to detect significant associations, particularly in subgroup analyses. Furthermore, the sole reliance on ICT for diagnosis, without confirmation by microscopy or molecular methods, may have affected diagnostic accuracy, potentially missing low-density infections or encountering issues related to HRP2 gene deletions. Additionally, data on potential confounding factors such as socioeconomic status, duration of residence in the area, and detailed housing conditions were not collected, which might influence malaria risk. The use of self-reported data for behavioral factors like mosquito net usage introduces the possibility of recall and social desirability bias. Finally, the absence of entomological data limits our understanding of local vector dynamics and their interaction with the identified risk factor.

Conclusion

The findings demonstrate that malaria remains a major public health challenge in Northern Sudan, requiring sustained, multifaceted control approaches. The comparable disease burden across population groups indicates that control programs should encompass both resident and displaced communities without exclusion. The varied effectiveness of preventive measures underscores the necessity for context-specific strategies that address local epidemiological, entomological, and behavioral factors. Future efforts should integrate enhanced vector control, community education on proper intervention use, and strengthened surveillance systems to effectively reduce the malaria burden in this and similar settings.

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